

RADIOACTIVE DECAY SERIES

Purpose:

This lesson will demonstrate for students that ionizing radiation is a part of nature and our natural environment, that it can result from human activity, and that radioactive materials spontaneously emit radiation during the process of radioactive decay.

Concepts:

1. Radioactivity is a fact of life on Earth and not necessarily the product of the nuclear age.
2. Radioactive chemical elements emit radiation in the form of alpha or beta particles and are transformed into other elements.
3. The emission of a gamma ray often accompanies alpha or beta decay.
4. There are three naturally occurring decay series beginning with the uranium-238, uranium-235, and thorium-232 that were present when the Earth was formed.

Duration of Lesson:

One 50-minute class period

Objectives:

As a result of completion of *Radioactive Decay Series* activities, the learner will be able to:

1. identify the atomic transitions occurring in a natural series;
2. identify the sources of the radioactive elements (i.e., "daughter products") in the naturally occurring decay series;
3. plot the atomic transitions in a chart of the nuclides; and
4. read and prepare a table from a chart of atomic transitions.

Skills:

Completing charts and tables, discussing, drawing conclusions, interpreting data from charts and tables, reading comprehension

Vocabulary:

Alpha particle, atom, beta particle, emit, gamma ray, nuclear radiation

Materials:

Reading Lesson

Radioactivity Review, p. SR-31

Activity Sheets

Atomic Transitions in the Natural Radioactive Decay Series, p. 139

Chart of the Isotopes in the U-238, U-235, and Th-232 Decay Series — Thorium-232 Series, p.141; *Uranium-235 Series*, p.143; *Uranium-238 Series*, p. 145

Transparencies

Chart of the Isotopes in the U-238, U-235, and Th-232 Decay Series (Thorium-232 Series), p. 137

Background Notes

Presenting Information on Radioisotopes: The "Chart of the Nuclides", p. 65

Suggested Procedure:

1. Before beginning the activity, a review of the structure of the atom, atomic number, and atomic weight may be helpful. These terms are discussed in the reading lesson entitled *Radioactivity Review*. Students should read the lesson that introduces the activity entitled *Radioactive Decay Series* and discuss alpha and beta decay thoroughly before proceeding.
2. Students should use the table of the atomic transitions in the Th-232 series and trace the plot of the transitions on the chart. It is recommended that this be done as a group activity.

Note: In the thorium decay series, when a bismuth-212 nucleus decays, it may emit either an alpha particle or a beta particle, but not both. Statistically, 66.3% emit a beta particle and 33.7% emit an alpha particle. This happens in other series, but the percentages are not usually this close; usually only a small percentage are "mavericks."

3. Using the table of transitions in the uranium-235 decay series, students should plot the transitions in the uranium-235 decay series on their chart.
4. Using the plot of the uranium-238 series on the chart, have students complete the table of the transitions in the uranium-238 series.

Sample Discussion Questions:

1. We say that an atom is the smallest part of matter that retains all chemical characteristics of an element. What do we mean when we talk about the chemistry of an element?
(Basically, the chemistry is the way the atom interacts with other atoms to form combinations or compounds. The interaction is dependent on the electrons in the atom.)
2. Isotopes of different elements may have the same atomic weight. What makes them different?
(Atomic number, which is the number of protons)
3. What are the numbers at the left of the elements on the chart of the isotopes?
(Atomic number/number of protons)

4. What are the numbers at the bottom of each box?
(The number of neutrons)
5. As a result of alpha decay, what happens to the atomic number and atomic weight?
(Goes down 2 in atomic number; atomic weight goes down 4)
6. As a result of beta decay, what happens to the atomic number and atomic weight?
(Goes up 1 in atomic number; atomic weight stays the same)
7. At the end of each decay series in the column for type of decay is the word stable. What does stable mean?
(A stable isotope is not radioactive and does not undergo radioactive decay. Each of the natural decay series ends in some isotope of lead.)

Teacher Evaluation of Learner Performance:

Verbal response of students in discussion and written response on activity sheets will indicate comprehension.

Student response to sample discussion questions will indicate an ability to interpret the data entered on student activity sheets.